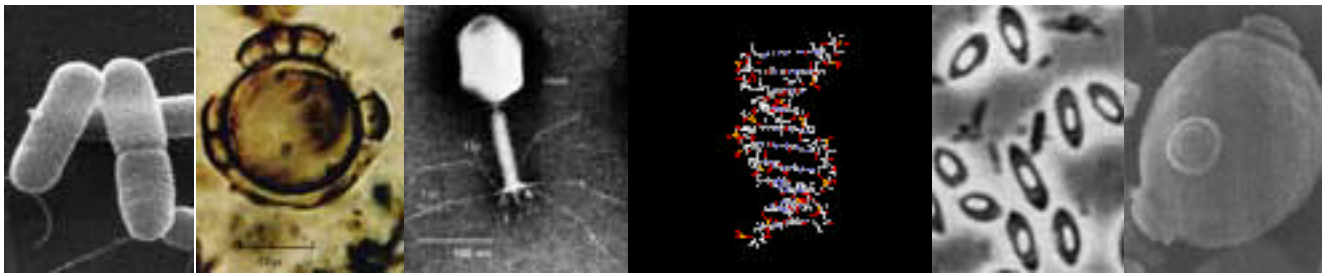

General Microbiology

Cañada College – Spring 2003

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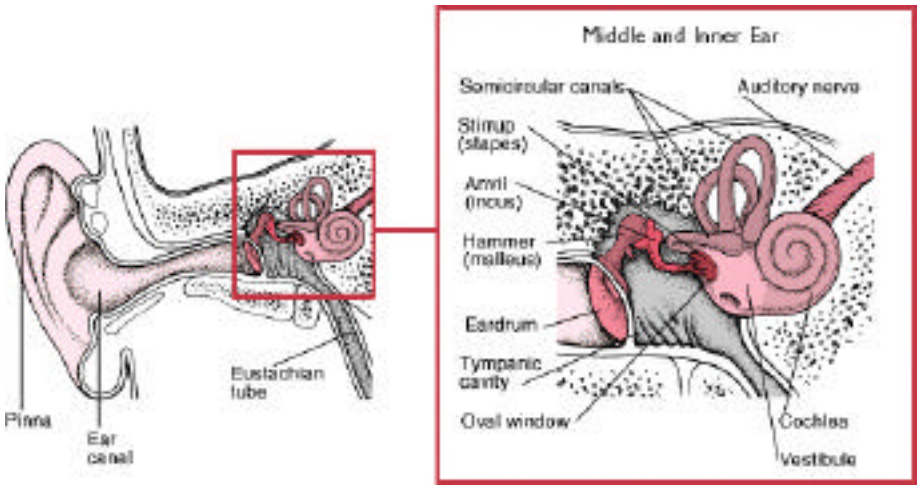
http://www-esd.lbl.gov/ESD_staff/torok/torok_lectures.html

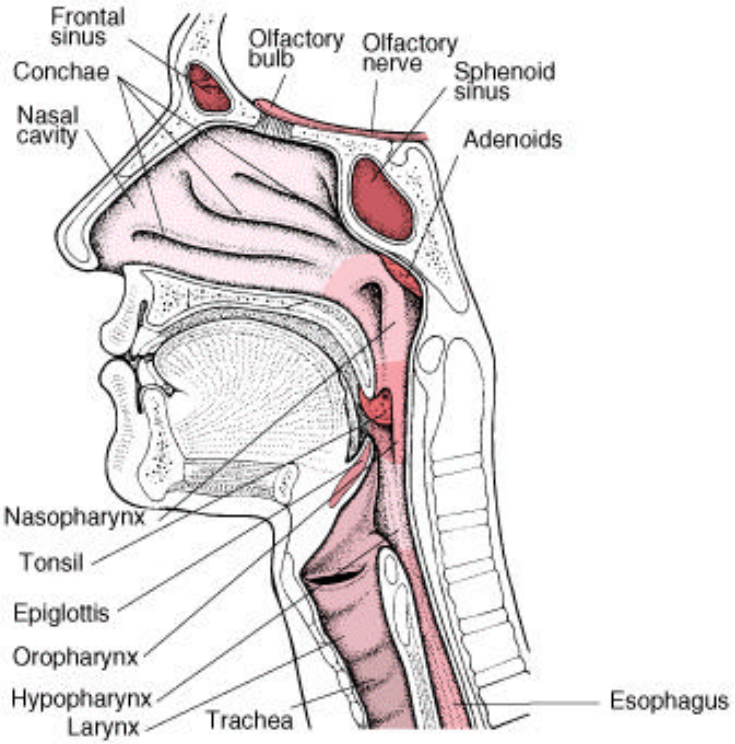
Topics for today

- Respiratory system
  - structure, function, and normal microbiota
  - microbial diseases of the upper respiratory system (URS) and the lower respiratory system (LRS)

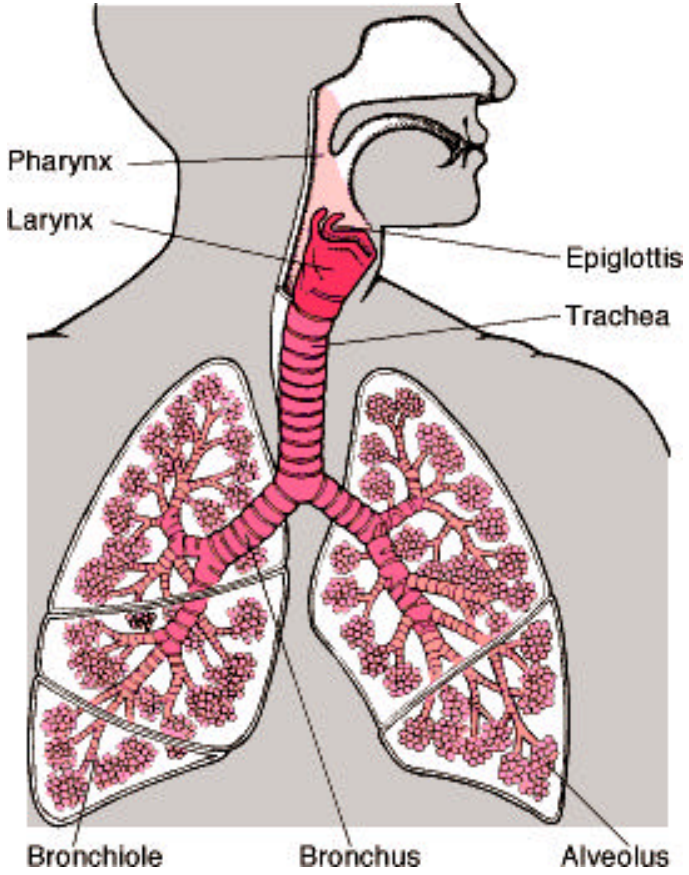
Upper respiratory system (URS)

- Nose, throat, associated structures
  - middle ear and the auditory tubes
  - sinus ducts and nasolacrimal ducts



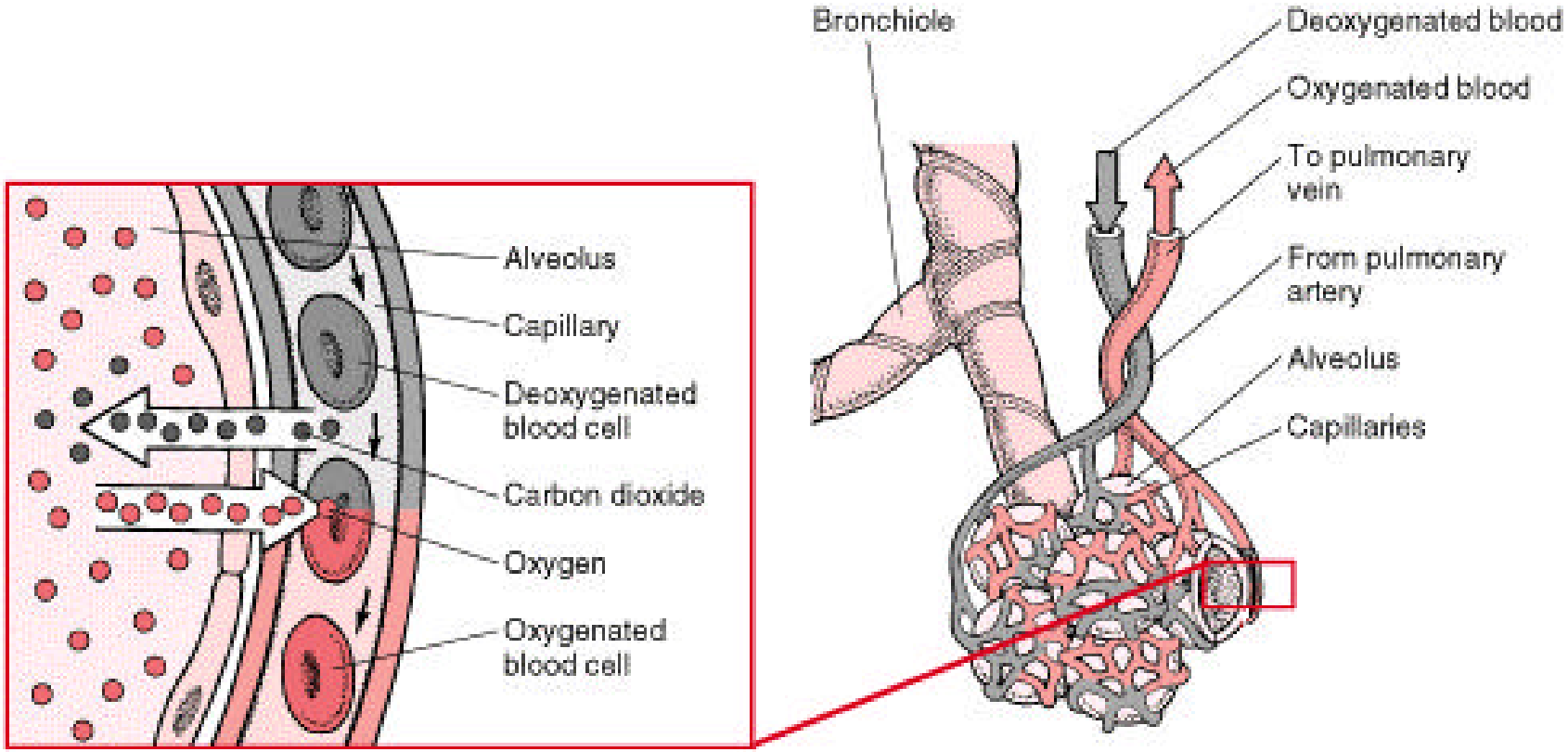


Lower respiratory system (LRS)



- Larynx, trachea, bronchial tubes, and 300 million alveoli (gas exchange area of some 70 m^2)
- Pleural membranes
- Cilia in the upper parts of LRS

Oxygen – carbon dioxide exchange



Defenses of the lung

- **Anatomical defenses**
  - nose hairs, nose mucous membrane
  - tonsils
  - cilia
- **Functional defenses**
  - oral microbiota
  - alveolar macrophages, neutrophils, natural killer cells, cytotoxic T cells
  - “activated macrophage defense”
- **Vaccination**

Normal microbiota

- Two main functions
  - organisms compete with pathogenic organisms for potential attachment sites
  - organisms often produce substances (toxins or acids) which are antimicrobial
- Normal microbiota in the URS
  - large numbers of S. aureus, S. epidermidis, corynebacteria
  - small numbers of S. pneumoniae, N. meningitidis, and H. influenzae can also be found
- LRS is nearly sterile

“Requirements” for pathogenic action

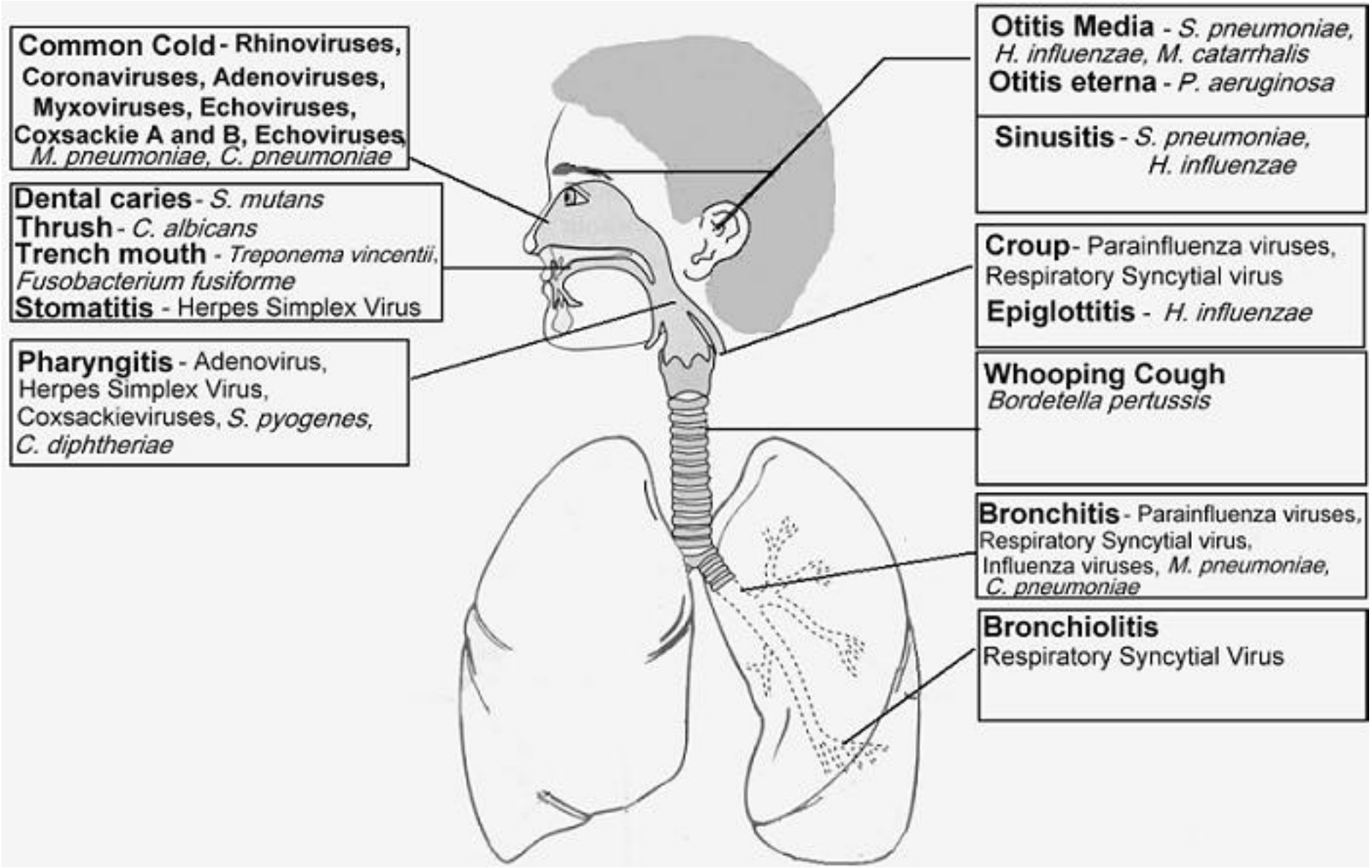
- Before a respiratory disease can be established
  - there must be a sufficient "dose" of infectious agent inhaled
  - infectious particles must be airborne
  - infectious organism must remain alive and viable while in the air
  - organism must be deposited on susceptible tissue in the host

Once pathogen is in the respiratory system…

- It has to colonize the surfaces before it can cause obvious disease
- Mechanisms of virulence
  - bacterial adherence factors → F and M proteins of S. pyogenes, hemagglutinins of B. pertussis
  - extracellular toxins → diphtheria toxin, pertussis toxin
  - growth in host tissue → viruses, Chlamydia sp.
  - evasion of host defense mechanism → capsules of S. pyogenes (also M protein), S. pneumoniae and H. influenzae by inhibiting phagocytosis

Respiratory tract pathogens

- Wide ranges of organisms
  - viruses (rhinoviruses, RSV, adenoviruses, influenza, parainfluenza)
  - group A streptococci (pharyngitis)
  - other streptococci (S. pneumoniae = sinusitis, Group B = pneumonia of infants)
  - other microorganisms (C. diphtheriae, Mycoplasma pneumoniae, fungi)
- Respiratory airway diseases
  - mostly viral bronchitis, tracheobronchitis, bronchiolitis (croup; epiglotitis)
- Parenchymal lung disease pneumonia
  - large number of bacterial infections in adults


Common Cold - Rhinoviruses, Coronaviruses, Adenoviruses, Myxoviruses, Echoviruses, Coxsackie A and B, Echoviruses, M. pneumoniae, C. pneumoniae
Dental caries - S. mutans
Thrush - C. albicans
Trench mouth - Treponema vincentii, Fusobacterium fusiforme
Stomatitis - Herpes Simplex Virus
Pharyngitis - Adenovirus, Herpes Simplex Virus, Coxsackieviruses, S. pyogenes, C. diphtheriae
Otitis Media - S. pneumoniae, H. influenzae, M. catarrhalis
Otitis eterna - P. aeruginosa
Sinusitis - S. pneumoniae, H. influenzae
Croup - Parainfluenza viruses, Respiratory Syncytial virus
Epiglottitis - H. influenzae
Whooping Cough
Bordetella pertussis
Bronchitis - Parainfluenza viruses, Respiratory Syncytial virus, Influenza viruses, M. pneumoniae, C. pneumoniae
Bronchiolitis
Respiratory Syncytial Virus

Pharyngitis

- ~90% of the sore throats are caused by viruses (adenoviruses, HSV,coxsackieviruses)
  - viruses gain access to the mucosal cells lining, replicate in the cells and damage them
- Chlamydia pneumoniae causes ~5%
- S. pyogenes – group A β–hemolytic Gram (+)
  - bacterial cell attaches to the mucosal epithelial cells via F and M proteins
  - cellular and extracellular products aid the bacterial invasion of the mucosa
- Corynebacterium diphtheriae – Gram (+) non–spore forming pleomorphic rod
  - damage is caused by the diphtheria toxin

Pharyngitis (cont.)

- Fever, sore throat, edema, hyperemia of the tonsils and pharyngeal walls are common
- Exudate containing pus is often seen with S. pyogenes sore throat or viral sore throat
- Rheumatic fever first presents with fever (1 01 °–1 04° F), and painful swelling of several joints such as the knees, elbows, or wrists
- Scarlet fever – lyzogenic S. pyogenes produces erythrogenic toxin

Diphtheria

- A contagious, sometimes fatal infection caused by the bacterium Corynebacterium diphtheriae
- Spread in droplets of moisture coughed into the air
- Bacteria multiply on or near the surface of the mucous membranes of the mouth or throat, where they cause inflammation (pseudomembrane)
- Some types of C. diphtheriae release a potent toxin, which can damage the heart and brain
- Antibody (antitoxin) treatment
- Widespread vaccination

Otitis media

- Bacterial or viral infection of the middle ear
- Complication of the common cold
  - viruses or bacteria from the throat can reach the middle ear through the eustachian tube or occasionally through the bloodstream
  - viral otitis media is usually followed by bacterial otitis media
  - eardrum becomes inflamed and may bulge, even rupture
- Antibiotic treatment

Common cold

- Viral infection of the lining of the nose, sinuses, throat, and large airways
  - ~50% are caused by rhinoviruses
    - infectious dose is 1 virus particle
  - 15–20% by coronaviruses
  - 10% by other viruses

Influenza

- Caused by the influenza virus
  - enveloped virus
    - neuraminidase (protein involved in viral exit
    - hemagglutinin (protein allows virus to enter human cells by attaching to sialic acid residues)
  - influenza virus types A, B, and C
  - genome is 7–8 segments of ssRNA
    - antigenic drift
    - antigenic shift
  - ciliated cells attacked – likelihood of secondary infection(s) increases

Respiratory airway diseases

- Croup
  - acute inflammatory disease of the upper airway
  - most common and serious hazard is the obstruction of the airway
  - particularly important for the very young since their airways are much more narrow
  - causative agents
    - H. influenzae type b (capsular type)
    - C. diphtheriae
    - parainfluenza viruses, adenoviruses, echovirus, influenza viruses, RSV
  - maintenance of adequate airways, control of infection

Pertussis

- Whooping cough is caused by B. pertussis (95%) or by B. parapertussis
- Pertussis toxin affects regulatory mechanisms and is responsible for most of the tissue damage
- Tracheal cytotoxin (part of the bacterial cell wall damages ciliated host cells), a hemolysin, and a filamentous hemagglutinin are also produced
- Erythromycin is the drug of choice

Tuberculosis

- Contagious, potentially fatal infection caused by the airborne bacteria Mycobacterium tuberculosis, M. bovis, or M. africanum
  - transmitted by inhaling indoor air contaminated with M. tuberculosis
  - a fetus may acquire by swallowing infected amniotic fluid
  - an infant may acquire by breathing in air containing infected droplets
  - bacterium proliferates in macrophages and ultimately kills them
  - more macrophages are recruited – damage to tissue – tubercle develops
  - walled off tubercle may calcify to a granuloma
  - activated macrophages can kill M. tuberculosis
  - if immune response does not control infection, calcified tubercle "liquefies" and bacteria break out – bacterium may enter the blood stream

Tuberculosis (cont.)

- 90–95% of all tuberculosis infections heal due to immune response
- Dormant bacteria cause 80% of infections (‘reactivation”)
- Pulmonary/extrapulmonary tuberculosis
- Treatment
  - isoniazid, rifampin, pyrazinamide, streptomycin, and ethambutol are used for treatment
- W strain

Bacterial pneumonia

- Infection of the lungs that involves the alveoli and the tissues around them
  - in adults – S. pneumoniae, S. aureus, Legionella spp., and H. influenzae
  - influenza virus and varicella can also cause pneumonia
  - Mycoplasma pneumoniae in older children and younger adults
  - fungi also cause pneumonia
  - deep-breathing exercises and therapy to clear secretions
  - antibiotics orally or intravenously injected